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Improving Learning Outcomes through STEM Learning Model and Self-Efficacy

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Abstract: *Education scholars have extensively studied the relationship between classroom exposure to STEM disciplines and favourable learning outcomes for students. The aim of this study is to investigate the potential correlation between students' self-efficacy and their learning outcomes in STEM-related courses. The main research approach employed in this quantitative analysis is descriptive verification. Every student enrolled at Banten Health Polytechnic participated in this study. This study employed an approach of selecting a sample at random. The study has a sample size of 100 students. Data was collected through the use of questionnaires for this research. This research utilises descriptive statistics and inferential statistics, namely PATH analysis conducted with Smart PLS 3.0 software. The STEM learning model had a significant impact on student learning outcomes ($p<0.05$), as well as on their self-efficacy ($p<0.05$). Additionally, the self-efficacy of students had a significant impact on the effectiveness of the STEM learning model ($p<0.05$). It is anticipated that additional research will result in a STEM education method that will empower all students to thrive. This research suggests that students can utilise STEM in the classroom for learning.*
Keywords: *Learning outcomes; self-efficacy; STEM.*

Meningkatkan Hasil Belajar melalui Model Pembelajaran STEM dan Efikasi Diri

Abstrak: Pakar pendidikan telah mempelajari secara ekstensif hubungan antara paparan disiplin ilmu STEM di kelas dan hasil pembelajaran yang menguntungkan bagi mahasiswa. Tujuan dari penelitian ini adalah untuk menyelidiki potensi korelasi antara efikasi diri mahasiswa dan hasil belajar mahasiswa dalam mata kuliah terkait STEM. Pendekatan penelitian utama yang digunakan dalam analisis kuantitatif ini adalah deskriptif verifikatif. Setiap mahasiswa yang terdaftar di Politeknik kesehatan Banten berpartisipasi dalam penelitian ini. Penelitian ini menggunakan pendekatan pemilihan sampel secara acak. Penelitian ini memiliki ukuran sampel 100 siswa. Data dikumpulkan melalui penggunaan kuesioner untuk penelitian ini. Penelitian ini menggunakan statistik deskriptif dan statistik inferensial yaitu analisis *PATH* yang dilakukan dengan software Smart PLS 3.0. Model pembelajaran STEM mempunyai pengaruh yang signifikan terhadap hasil belajar mahasiswa ($p<0,05$), dan juga terhadap efikasi diri mahasiswa ($p<0,05$). Selain itu, efikasi diri mahasiswa mempunyai pengaruh yang signifikan terhadap efektivitas model pembelajaran STEM ($p<0,05$). Penelitian tambahan diharapkan dapat menghasilkan metode pendidikan STEM yang akan memberdayakan semua siswa untuk berkembang. Penelitian ini menyarankan agar mahasiswa dapat memanfaatkan STEM di kelas untuk pembelajaran.
Kata Bantu: Efikasi diri; hasil belajar; STEM.

1. Introduction

Education scholars have extensively studied the relationship between classroom exposure to STEM disciplines and favourable learning outcomes for students. Nevertheless, a universally accepted definition of STEM education does not exist (Baran et al., 2016; Bybee, 2013; Hsu et al., 2017; Wahono et al., 2020). Learning outcomes are the specific achievements that arise from the process of teaching and learning. These outcomes can encompass cognitive abilities, emotional development, or psychomotor skills (Hidayat & Suryadi, 2023; Novita & Sundari, 2020).

Effective teacher management of the learning process is crucial for attaining learning outcomes that prioritise social communication exchanges. The significance of employing imaginative and groundbreaking approaches in the process of acquiring knowledge is underscored (Lai et al., 2018). Teachers play a crucial role in education by creating and executing lesson plans, evaluating students' advancement towards learning objectives, and

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analysing the efficacy of their teaching methods. In the same way, a teacher must possess the ability to select a suitable learning model for his students, taking into account their individual attributes (Tjabolo & Herwin, 2020). In contemporary times, STEM education has emerged as a highly favoured teaching methodology. The objective of STEM education is to provide students with the information and skills necessary to apply scientific, technological, mathematical, and engineering principles in order to address real-world problems. STEM programmes prioritise practical training (Yıldırım & Sidekli, 2018).

Students are urged to investigate ambiguous projects that utilise STEM in a limited setting. There is a general consensus that successful STEM education should incorporate student-centered methodologies, practical exercises, and the promotion of teamwork, team communication, knowledge acquisition, and formative evaluation. Exposure to STEM courses can enhance kids' self. The self-assurance acquired via engagement in STEM-related activities is immeasurable. According to Samsudin et al. (2020), students should cultivate a growth attitude by perceiving their assignment as a challenge and subsequently exerting conscientious effort to accomplish it through the utilisation of their analytical and problem-solving abilities. Students with a strong belief in their own ability to successfully complete tasks possess high self-efficacy (Jamali et al., 2015). Students who possess a strong belief in their own capabilities are more inclined to persist in their efforts until they achieve success. Self-efficacy is also a crucial determinant of academic achievement (Doordinejad & Afshar, 2014).

Researchers at the Banten Health Polytechnic found that students exhibited a lack of self-assurance when it came to performing hands-on learning activities and faced difficulties in fulfilling practical assignments given by instructors across all subjects, leading to unsatisfactory academic achievements. This study examines the correlation between the STEM learning approach and student academic achievements. The purpose of the STEM learning paradigm and student self-efficacy is to enhance student learning outcomes. Previous studies have shown that using a mastery-based approach to STEM education can have a substantial influence on students' academic achievements (Çevik & Bakioğlu, 2022). Proficient English-speaking students demonstrate a notable association between their self-efficacy scores and their language skills, as evidenced by statistical analysis (Chen, 2020).

There is evidence from this study that both students and teachers can benefit from incorporating STEM into their classroom instruction. The objective of this research is to elucidate the correlation between the STEM learning model and self-efficacy in relation to student learning outcomes. This research distinguishes itself from prior studies by utilising the STEM learning paradigm and student self-efficacy to augment student learning outcomes. Therefore, the purpose of this study is to tackle the following concerns: STEM have a direct impact on student learning outcomes, there a direct correlation between student self-efficacy levels and student learning outcomes, STEM learning paradigm indirectly influence student learning results through student self-efficacy levels.

2. Research Method

This study employs a quantitative methodology. The research included just students from Banten Health Polytechnic. Random sampling was used to conduct the inquiry. The study's sample size included one hundred students. The primary factor being examined in this study is the STEM learning model (X1), which comprises four indicators (Torlakson, 2014): (1) representative science pertaining to the principles and concepts governing the natural world; (2) technology as a skill or system employed in the management of society, organisation, knowledge, or the creation and utilisation of artificial tools to enhance productivity; (3) engineering, which involves the knowledge and ability to devise and implement procedures for problem-solving; and (4) mathematics, which encompasses the knowledge and ability to devise and implement procedures for solving mathematical problems. By integrating these components into the learning process, each one has the potential to enhance the meaningfulness of knowledge.

The second independent variable in this study is self-efficacy (X2), which consists of four indicators (Lunenburg, 2011): (1) achievement of success. The experience of accomplishment, based on genuine personal experience, is the most powerful determinant of an individual's sense of self-efficacy. Achievement enhances an individual's self-efficacy, but consistent lack of success diminishes self-efficacy. (2) The firsthand accounts of others, encompassing Likewise, an individual's confidence in their ability to succeed in a specific domain will grow when they witness the accomplishments of others in that same

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domain. Individuals convince themselves by saying that others have successfully completed the task. (3) Verbal persuasion, particularly via the use of words, is employed to convince someone of their ability to accomplish their objectives. The teacher's attitude and communication towards the students are present in this dimension. The user's text is "(4)". An individual's opinion of their ability to accomplish a task is influenced, to some extent, by their physiological state. The mental distress and physiological conditions experienced by individuals act as a forerunner to the onset of anything unwanted, thereby leading to the avoidance of stressful situations. The dependent variable (Y) in this study refers to the learning outcomes, encompassing intellectual skills, cognitive strategies, attitudes, linguistic knowledge, and motor skills (Nasution, 2018).

Data collection for this study was conducted using a questionnaire. Questionnaires are frequently employed by researchers to obtain information and data from individuals. Data for this study was collected using a Likert scale. Participants are requested to evaluate their degree of agreement on a Likert scale ranging from one to five. The Likert scale was created to enable a variety of responses to several questions. This analysis utilised a 5-point Likert scale. This study utilises descriptive statistics and inferential statistics, notably PATH analysis conducted with Smart PLS 3.0 software, to analyse the data. Researchers analyse the influence of both X1 and X2 on Y, as well as the indirect effect of X1 on Y mediated by X2. Figure 1 illustrates the complete framework of the analytical model. Validity and reliability indicators for each latent variable are computed while administering the test. The minimum acceptable reliability value is r = 0.300. According to Sugiyono (2022), any items on an instrument are considered invalid if their total correlation score falls below 0.300. Meanwhile, the split-half method was employed to test for reliability. A higher level of consistency in an instrument necessitates a reliability coefficient of its associated variables that is over 0.700 or 70% (Wibisono, 2022).

3. Result and Discussions

Throughout the instrument testing process, researchers assess the dependability and accuracy of the indicators utilised to quantify every concealed variable. R = 0.300 is the bare minimum threshold for validity. Alternatively stated, the components of the instrument are considered invalid if their correlation coefficient is 0.300 or lower (Sugiyono, 2022). During this time period, the split-half method was also employed to evaluate reliability. We say a variable of a given instrument can be relied upon if its coefficient of reliability is greater than 0.700; the greater the dependability, the more consistent the instrument (Wibisono, 2022). The details regarding the validity and reliability of the instrument are presented in Table 1.

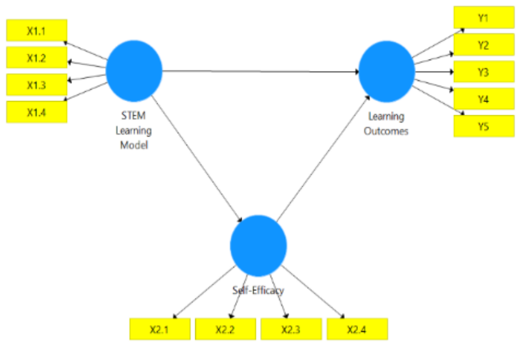

Figure 1 displays the model of the theoretical research framework.

Table 1. Validity and reliability analysis results

Item	STEM		Self-efficacy		Learning outcomes	
	V	R	V	R	V	R
1	0.750	0.875	0.850	0.800	0.750	0.930
2	0.850		0.870		0.870	
3	0.917		0.927		0.940	
4	0.850		0.860		0.855	
5	0.830		0.840		0.860	
6	0.775		0.770		0.865	
7	0.870		0.852		0.850	
8	0.920		0.930		0.910	
9	0.870		0.860		0.950	
10	0.760		0.730		0.840	
11	0.860		0.855		0.850	
12	0.734		0.750		0.740	
13	0.745		0.750		0.777	

The correlation coefficient (r = 0.195) in Table 1 indicates that the impact of the STEM learning paradigm and self-efficacy on student learning outcomes is statistically significant. The Cronbach's alpha value, which is employed to assess reliability, is likewise significantly high. The used instrument seems to be valid and dependable based on the established criteria. After doing the study to determine the validity and reliability of the instrument, the subsequent step is to perform a path analysis using the framework model depicted in Figure 1. A graph is used here to illustrate the theoretical relationship between the variables. Smart PLS version 3.0 utilises the path coefficient value to compute the path test.

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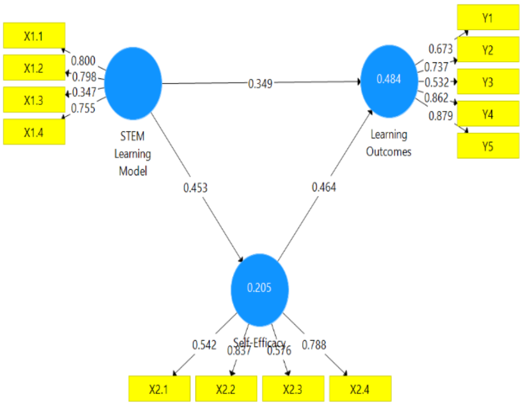

Figure 2 displays a path analysis model

Figure 2 illustrates the degree of correlation between several constructs or variables. Path coefficients quantify these interactions.

Table 3: Assessing the statistical significance of both direct and indirect impacts

Variable	Effects	Mean	Std. Deviation	T Value	p
X1→Y	Direct	0.458	0.098	3.555	0.000
X2→Y	Direct	0.570	0.085	5.568	0.000
X1→X2 →Y	Indirect	0.560	0.086	5.570	0.000

The data presented in Table 3 indicates that X1 has a significant and direct impact ($p<0.05$) on Y. The method by which students acquire knowledge in the STEM paradigm has a substantial influence on their educational achievements. STEM education has a beneficial impact on critical thinking skills, namely on the subscale of "truth-seeking and open-mindedness". The STEM activities employed in this study enhanced students' tendency towards critical thinking (Hacioglu & Gulhan, 2021). STEM education is crucial for students to develop the necessary skills for the 21st century, including problem-solving, innovation, creativity, communication, and cooperation (Cooper & Heaverlo, 2013; Sari et al., 2020). Students in STEM education engage in the exploration and development of practical solutions to tangible challenges in the world. Real-world problems are inherently multidisciplinary and necessitate the application of knowledge and skills from multiple disciplines in order to be effectively resolved. Thus, to address this issue, students need to adopt an interdisciplinary approach, drawing upon knowledge and abilities from many fields, in accordance with the core nature of the problem (Wang et al., 2011). The table labelled as Table 3 demonstrates the indirect impact of self-efficacy on the outcomes of student learning. The indirect effect has a statistically significant influence ($p< 0.05$). Self-efficacy serves as a mediator in the connection between the STEM learning model and the academic achievements of students. This is supported by evidence from (Samsudin et al., 2020). Utilising the STEM method to enhance students' problem-solving skills.

This study poses three research inquiries. This article explores enhancing learning outcomes using STEM educational approaches and self-efficacy in one's abilities. This section examines the outcomes of utilising STEM learning methods and self-efficacy. Three primary discoveries emerged from this investigation. Using STEM learning paradigms and self-efficacy to address this research issue is supported by study findings. Is there a direct impact of STEM on student learning outcomes? The research results indicate a significant impact of the STEM learning model on student learning outcomes, as shown in table 3 with a significance level of $p < 0.05$. The findings of this study support the idea that employing the STEM learning strategy positively impacts student learning outcomes, as indicated by (Azhar et al., 2022; Utami & Nurlaela, 2021; Wahono et al., 2020). STEM activities in the classroom aim to enhance the quality of the learning process (Meyrick, 2011).

Is there a direct association between student self-efficacy levels and student learning outcomes? Research indicates that the amount of self-efficacy directly impacts student learning outcomes. This research aligns with other studies (Gumelar & Sary, 2021; Nurulwati et al., 2020; Rorimpandey & Midun, 2021) by demonstrating that student self-efficacy significantly impacts learning outcomes related to understanding and applying concepts. Application-related learning outcomes refer to students' capacity to apply acquired concepts in novel and practical scenarios (Lubis et al., 2019).

The third research question investigates whether the STEM learning paradigm impacts student learning outcomes indirectly through student self-efficacy levels. The third research indicates an indirect impact of STEM education on student learning results via student self-efficacy levels. This is supported by the research findings presented in table 3. This research aligns with (Muthi'ika et al., 2018) by showing that the STEM learning approach can greatly enhance student learning results by boosting self-efficacy. STEM education is a multidisciplinary method that necessitates students to possess knowledge and abilities in the areas of science, technology, engineering, and mathematics (Avery & Reeve, 2013). This research suggests that students can utilise STEM in the classroom for learning.

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4. Conclusions

This study indicated three noteworthy and statistically significant findings from its results and discussion: first, that the STEM learning model significantly affects student learning outcomes ($p<0.05$) and second, that it significantly affects student self-efficacy ($p<0.05$). In addition, the efficiency of the STEM learning model is significantly affected by student self-efficacy ($p<0.05$). We can only hope that more studies will lead to STEM teaching strategies that enable every student to thrive. There is evidence from this study that both students and teachers can benefit from incorporating STEM into their classroom instruction.

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